The Operational use of AIRS at the Met Office

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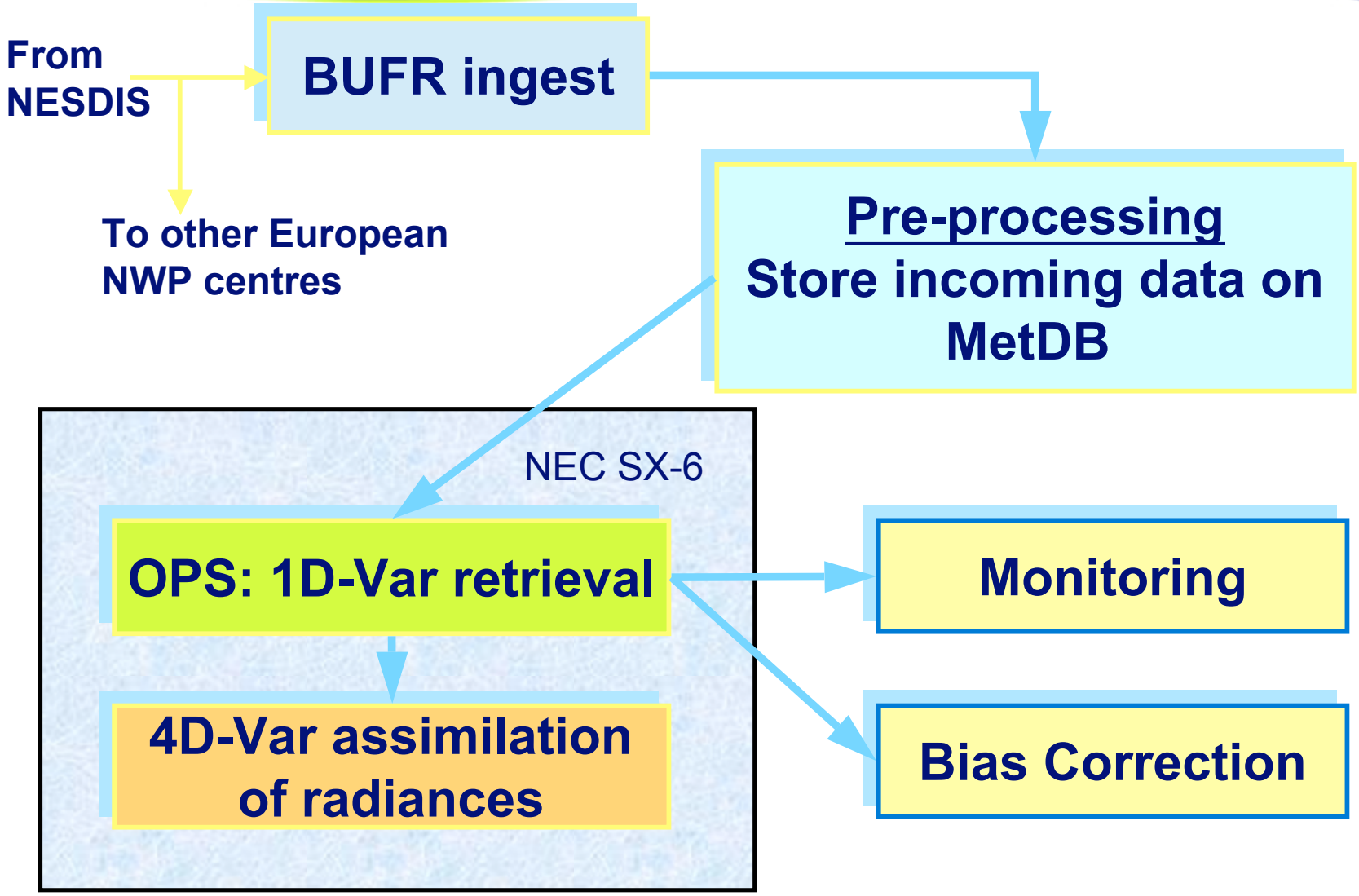
The Operational System

Operational Status

- AIRS data has been operationally assimilated at the Met Office since 26th May 2004.
- Conservative first implementation
- Moderate positive impact on top of 3 AMSU

AIRS data processing at the Met Office



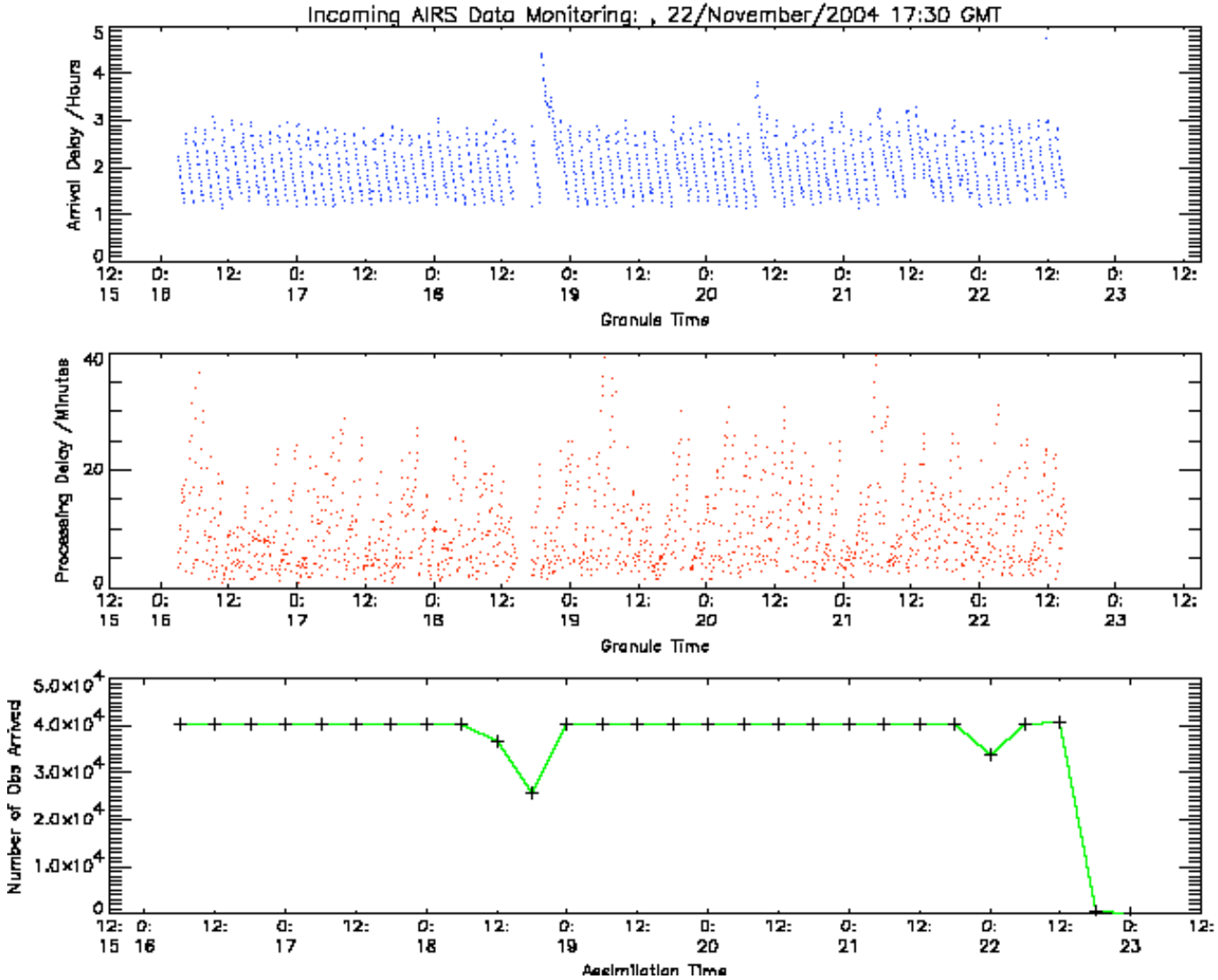
Number of Observations used in 1DVAR

- We receive 1 in 18 FOVs from NESDIS.
- For each 1D-Var cycle we receive:
  - 10-20,000 observations per “main run”
  - 40,500 observations per “update run”
- Only cloud-free observations over the sea are used, which constitute about 7-8% of the data.

Number of Observations used in 4DVAR

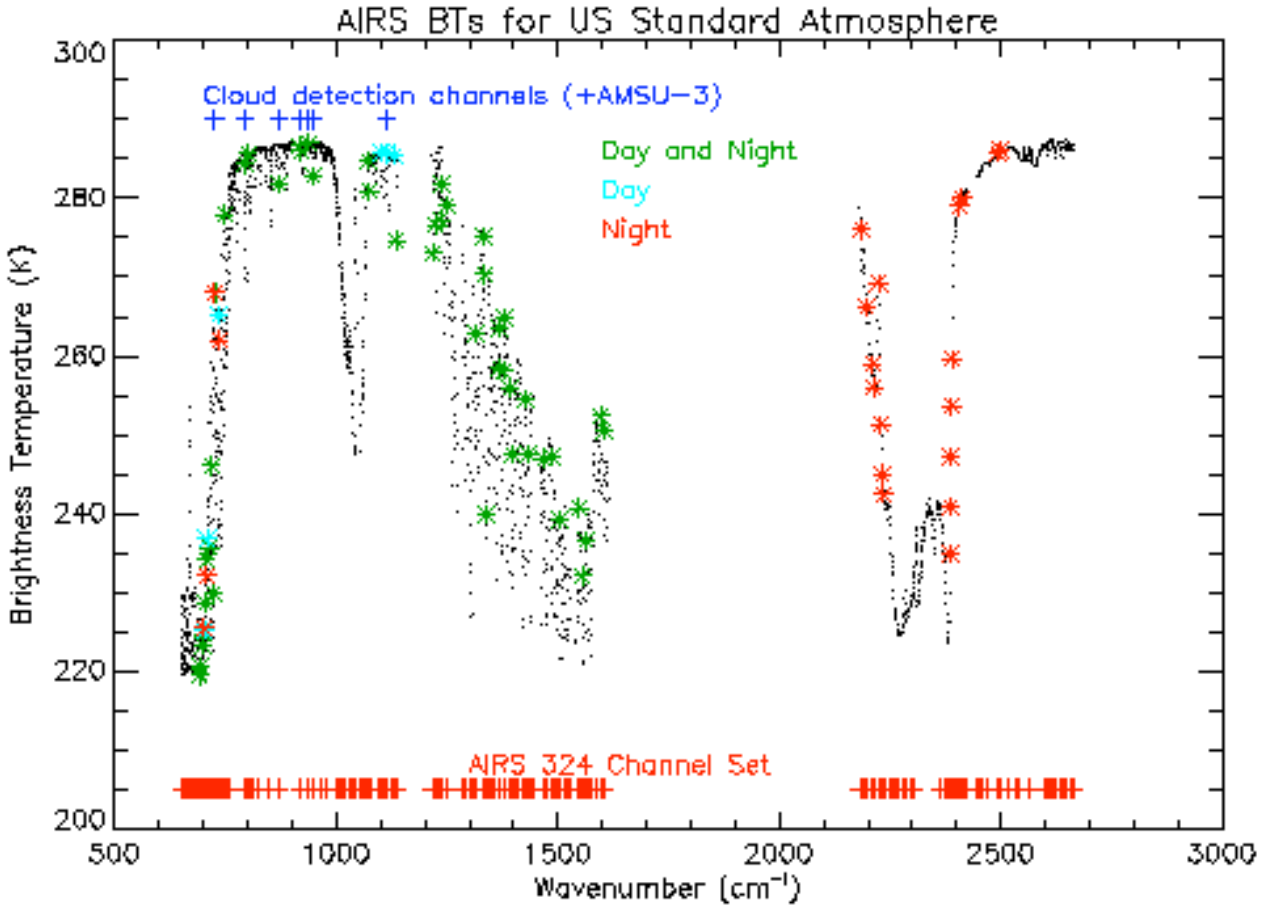
- Spatial thinning further reduces the fraction of data used to about 4-5%.
- For each 4D-Var cycle we assimilate:
  - 500-1000 observations per “main run”
  - About 1700 observations per “update run”

Data Timeliness

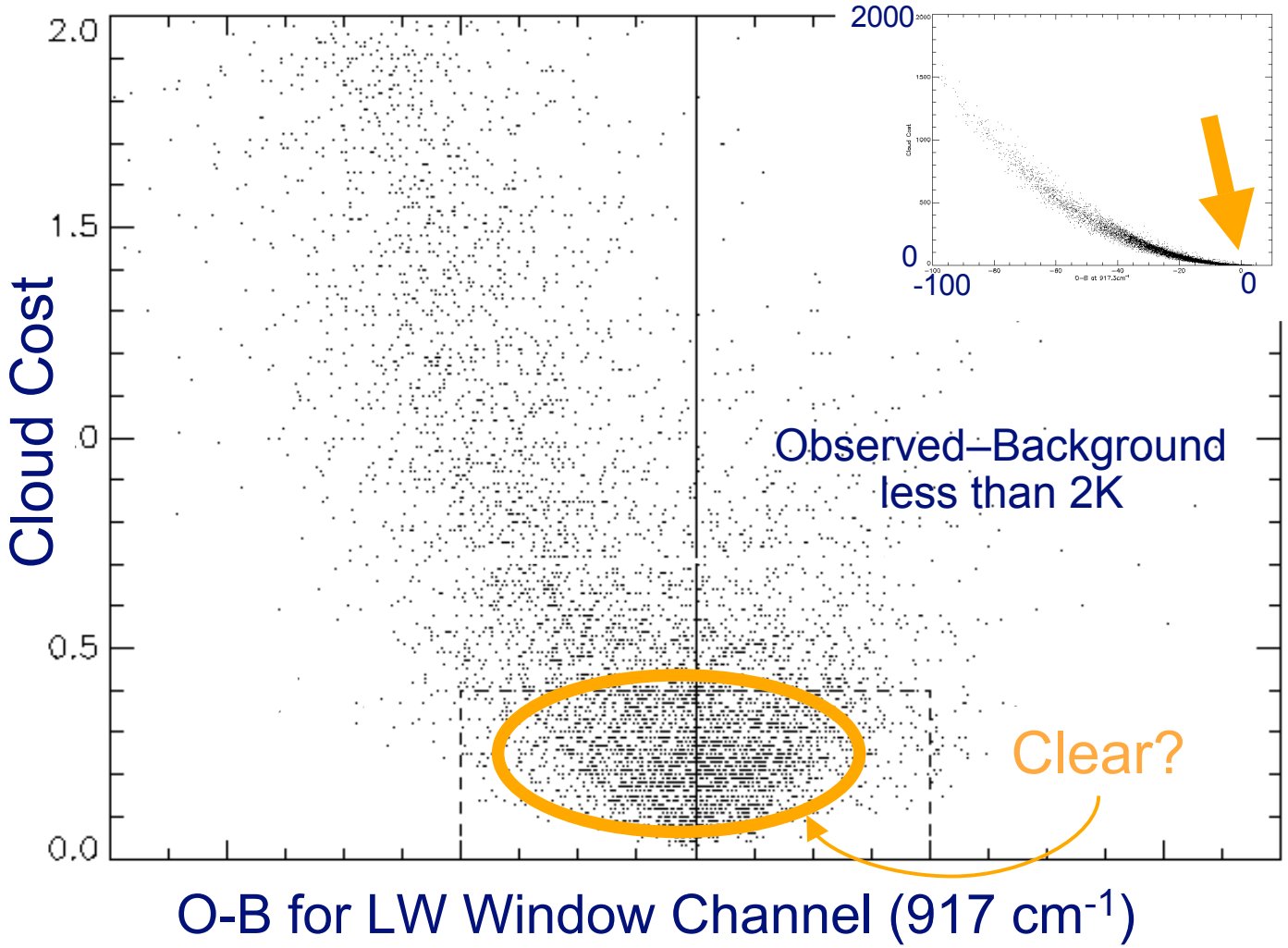


Channel Selection

- 324 AIRS channels supplied
- Assimilate a subset of 45 (day) or 60 (night)
- Exclude channels (137 in all) that:
  - Have a large contribution from above the model top
  - Are significantly affected by ozone
  - Have less robust Jacobians
  - Are noisy
- Choose those with highest impact on degrees of freedom for signal (Rodgers, 1996)



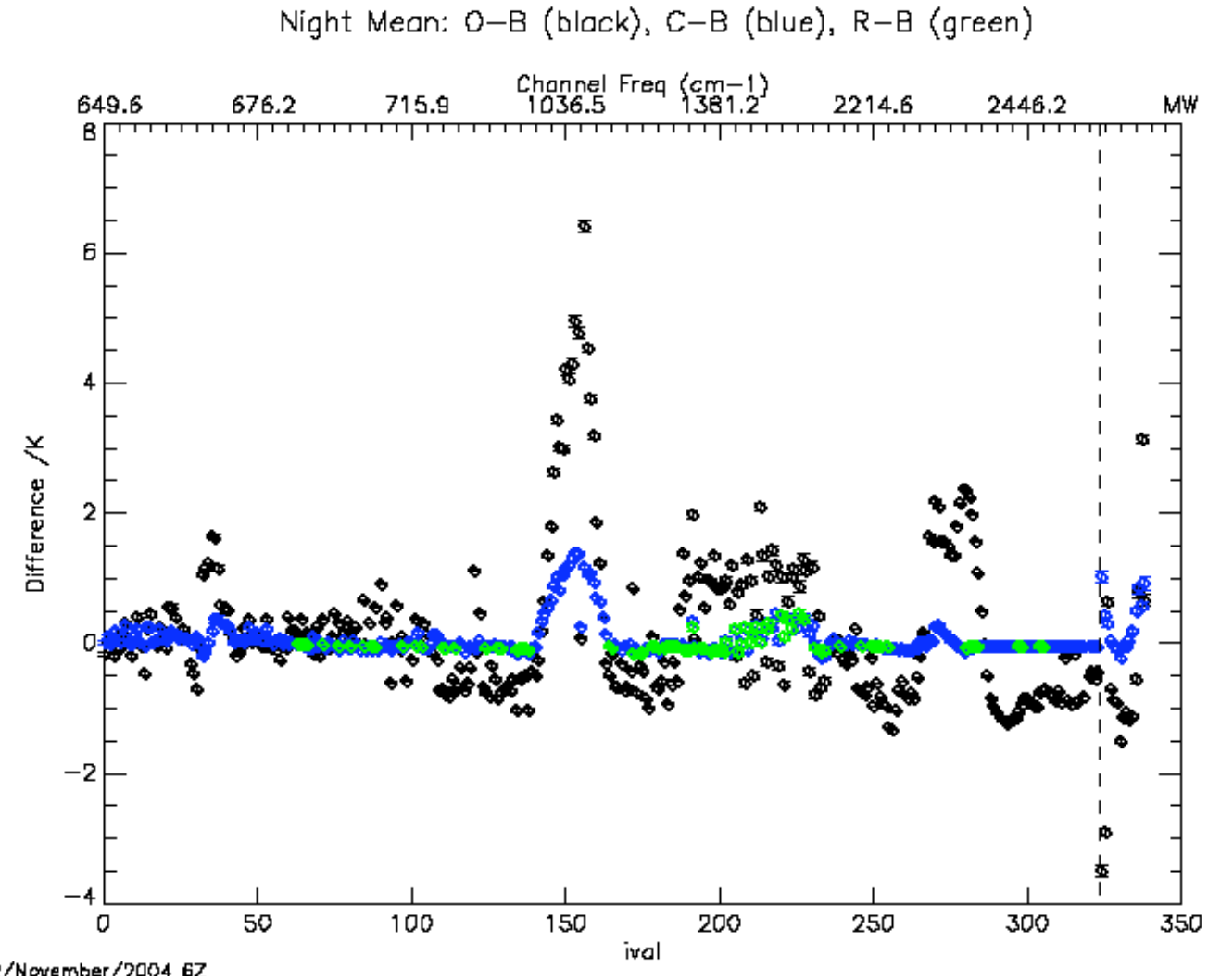
Variational Cloud Detection



Cloud Cost:
Attempt to determine the probability of having cloud in the field of view, given the observed radiances and the NWP background profile (English, Eyre and Smith, 1999)

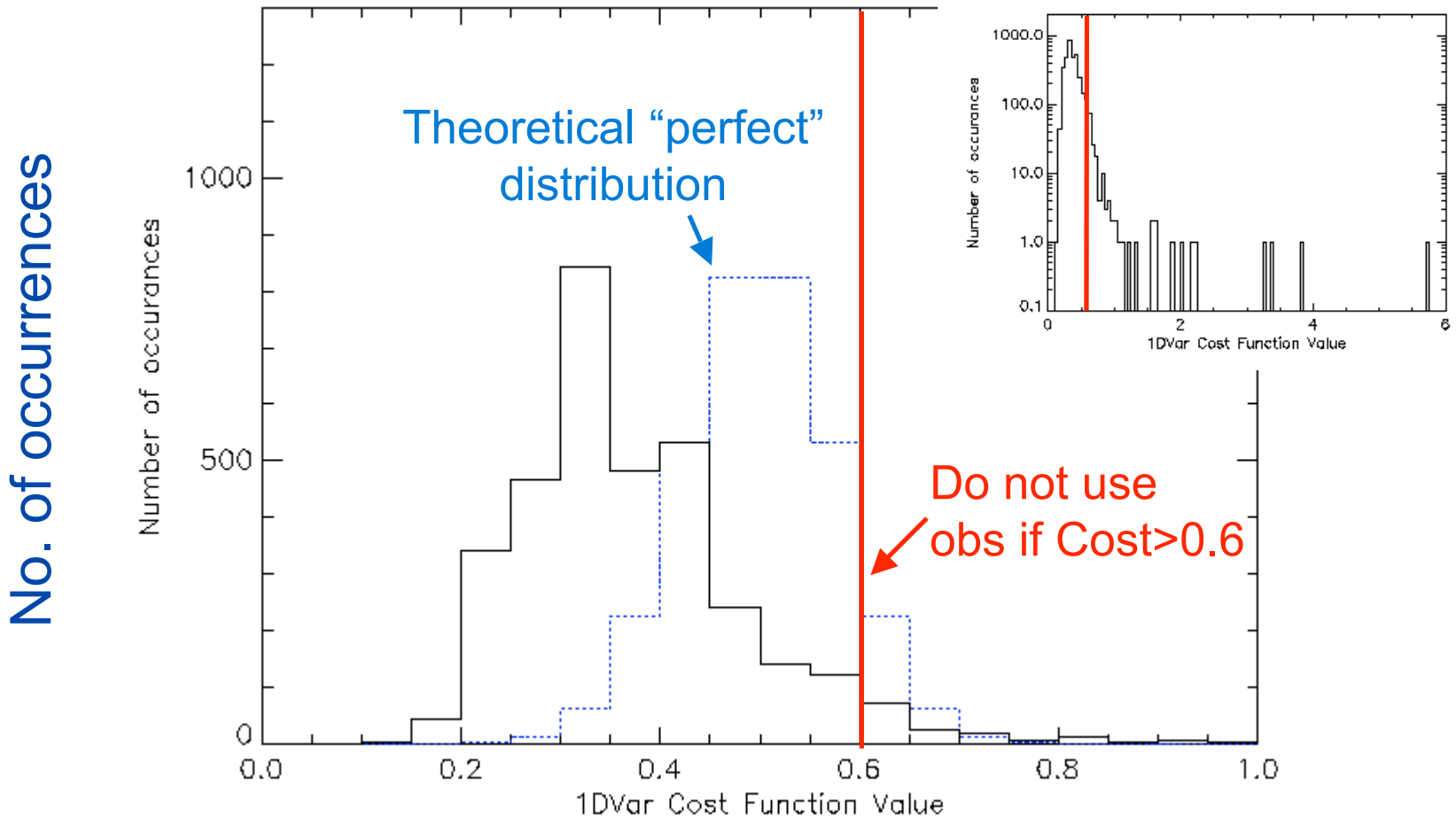
Bias Correction and Monitoring

- Scan Angle plus two predictors
- 850-300 hPa thickness
- 200-50 hPa thickness
- Should perhaps try gamma-delta method.



http://www.metoffice.gov.uk/research/nwp/satellite/infrared/sounders/airs/main.html

1D-Var Cost Distribution

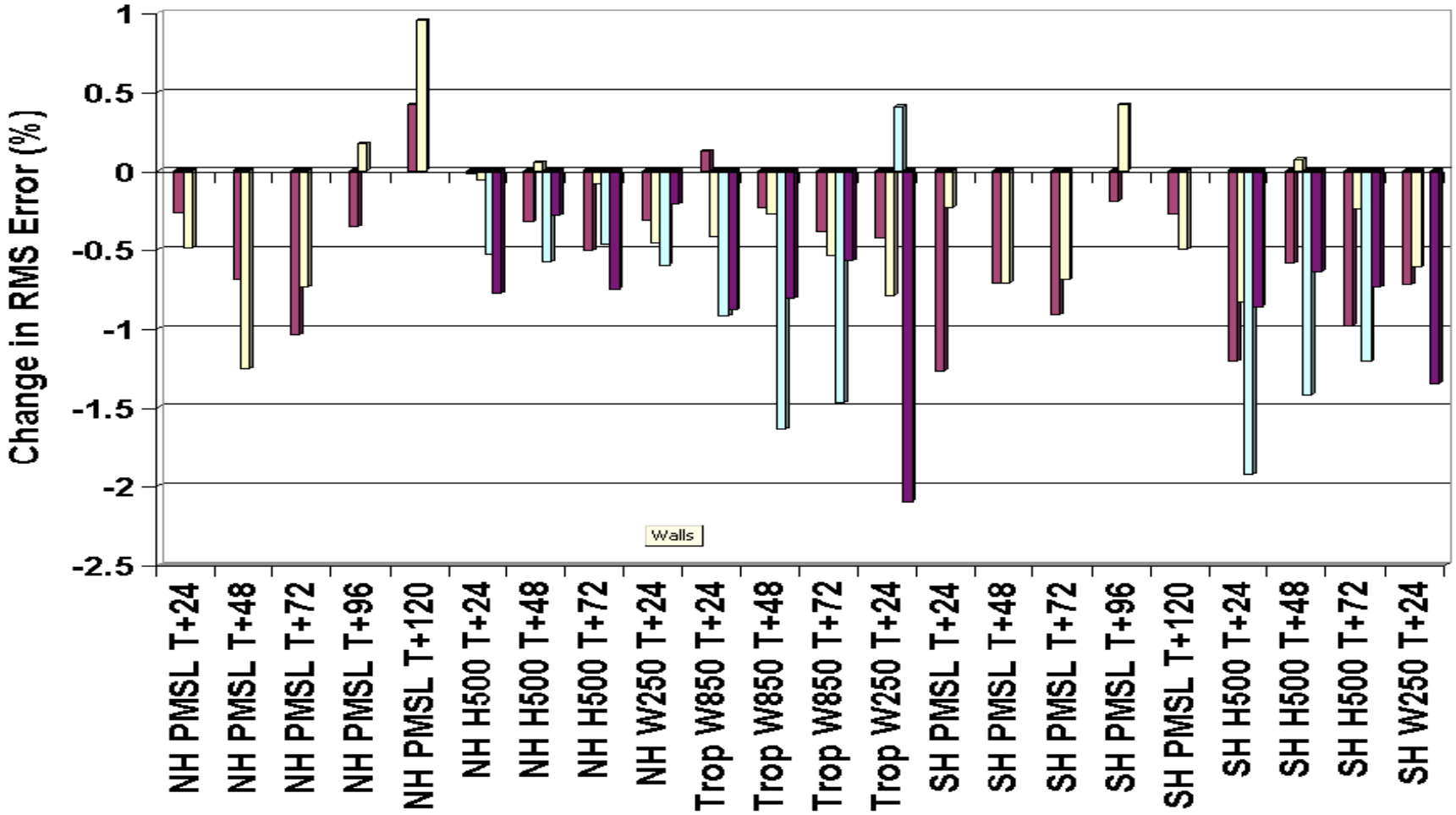


1D-Var Cost Function Value

Pre-operational Trials

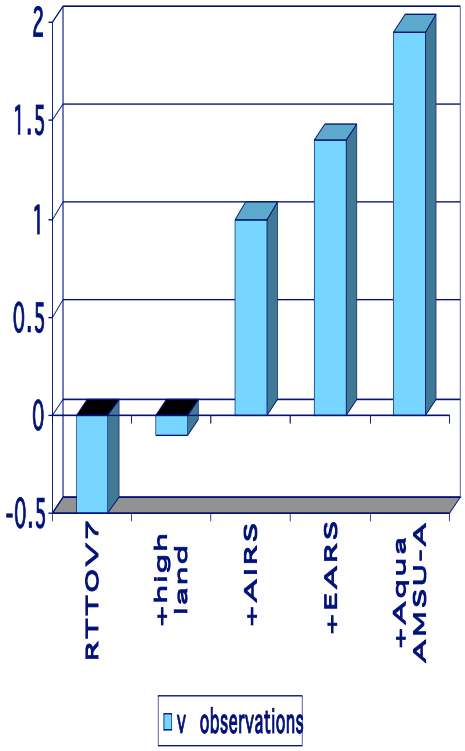
NWP Trial

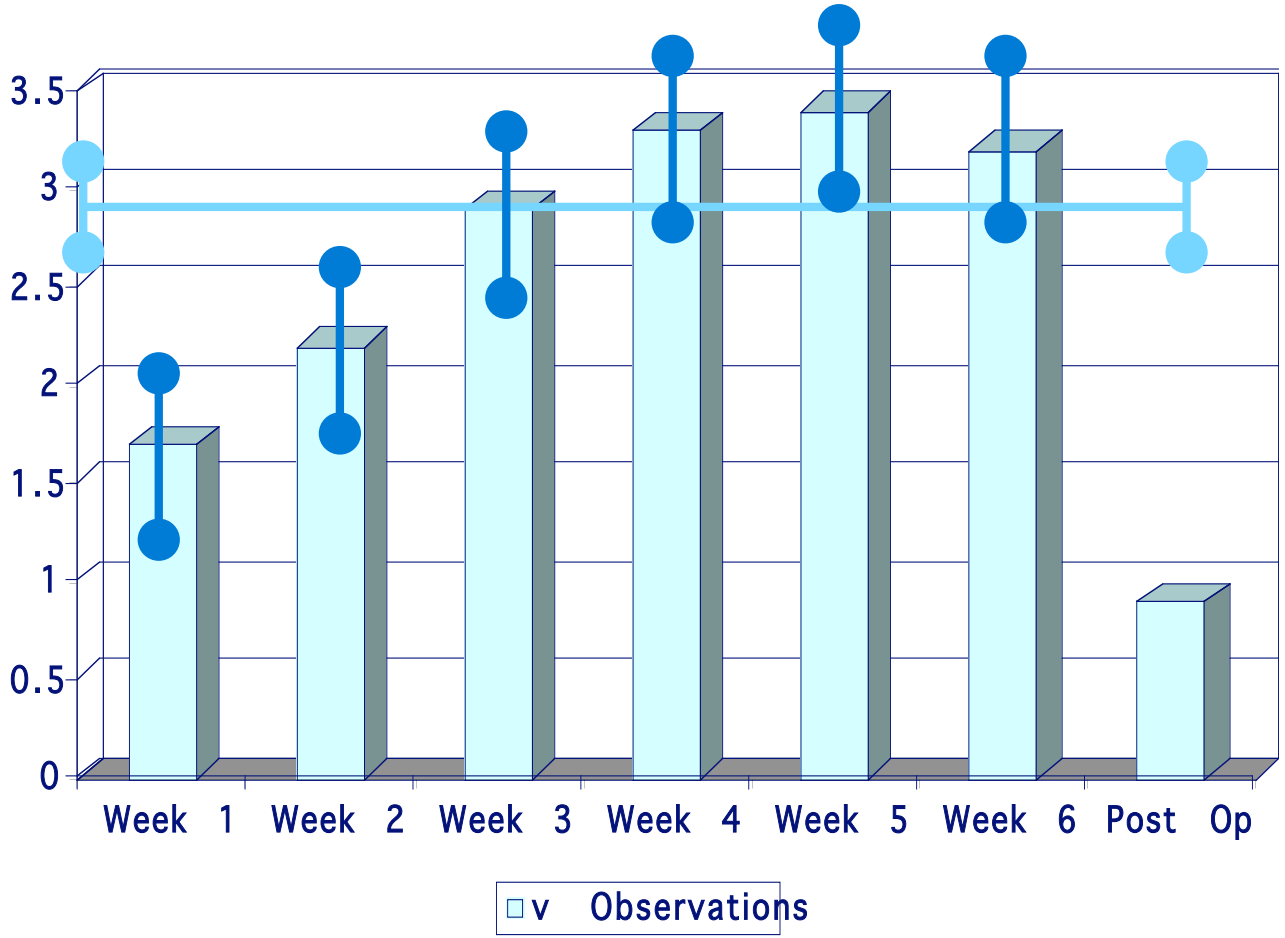
Impact of AIRS trial: +0.4/0.5 on NWP Index



Near Real Time Pre-Operational Trial

AIRS was implemented as part of a package of upgrades to the use of satellite data.



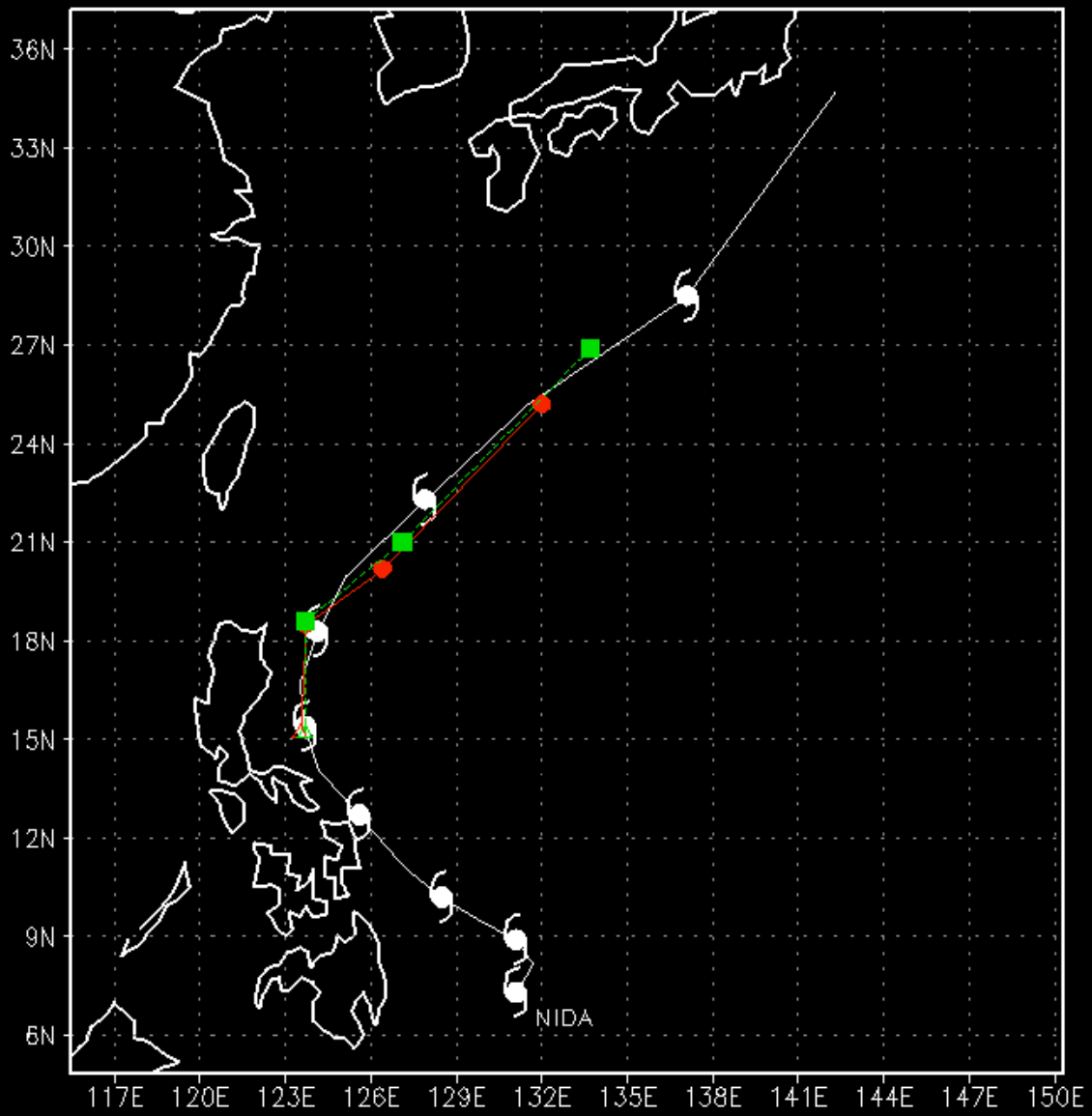


Tropical Cyclone Verification

- Results from Julian Heming:
- We have found major positive impact
  - positions 10% better, intensity increased, picked up more quickly and developed more rapidly (well before TC bogus kicks in).
- First TC post upgrade was superbly forecast (again well analysed before TC bogus).
- Combined with ECMWF experience (step improvement when AIRS and Aqua AMSU-A went in) we can say with reasonable confidence that AIRS has an important impact on TC forecasts.

CONTROL and TRIAL

FORECAST TRACKS of SUPER TYPHOON NIDA



CN 20040517 TR 20040517

KEY to FORECAST TRACKS

(Triangles denote analysed positions)

24 HOURLY REAL TIME OBSERVED POSITIONS

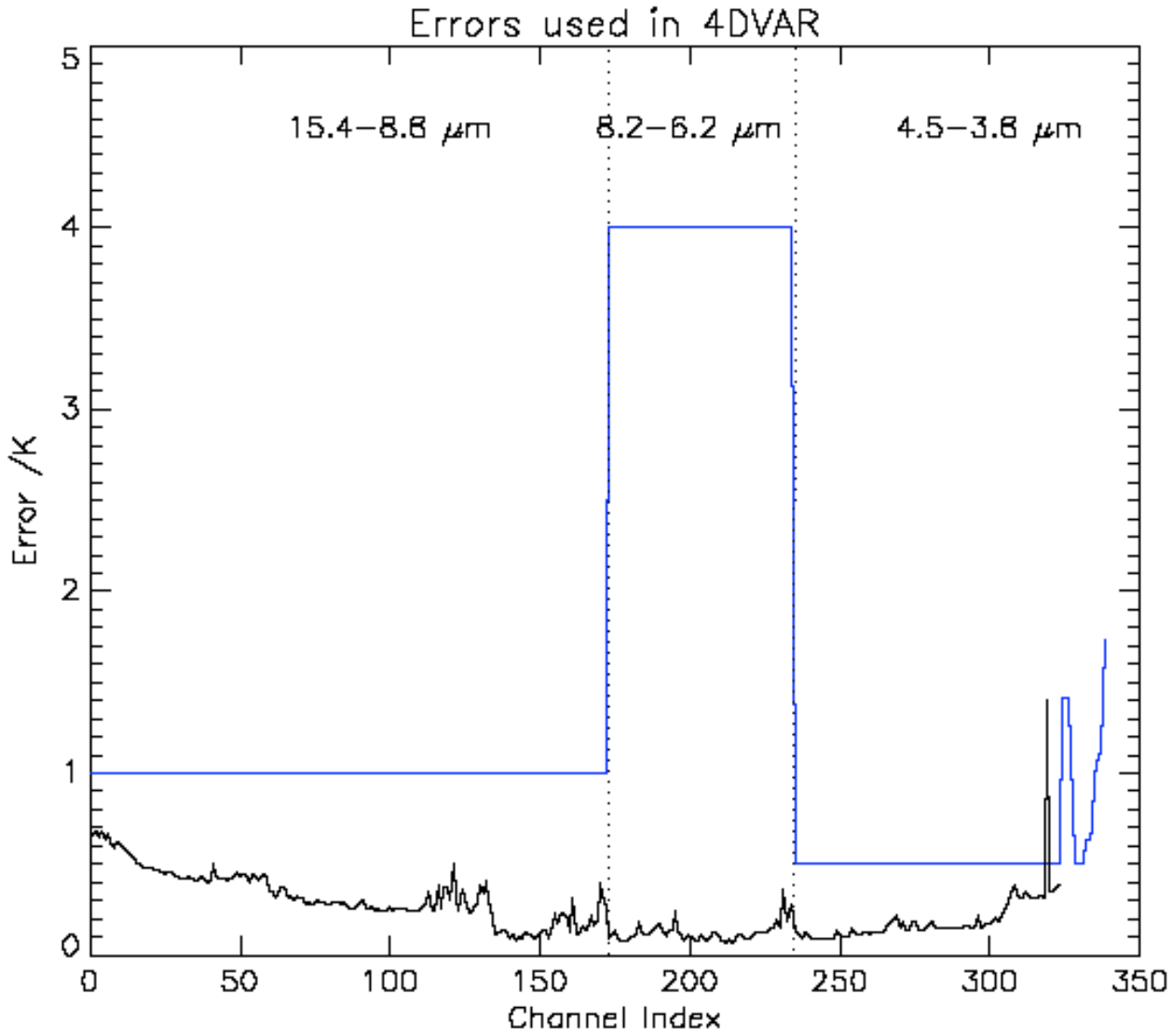
DATE/TIME OF FIRST SYMBOL 12Z 13 MAY 2004

Work in Progress

Observation Error in 4DVAR

Observation Error:

- Forward Model Error
- Non-Linearity Error
- Instrument Noise
- Errors of Representivity



Representivity Error

Compare O and B for two channels i and j
for two *nearby* FOV, at points a and b:

It is possible to argue that this reduces to three terms:

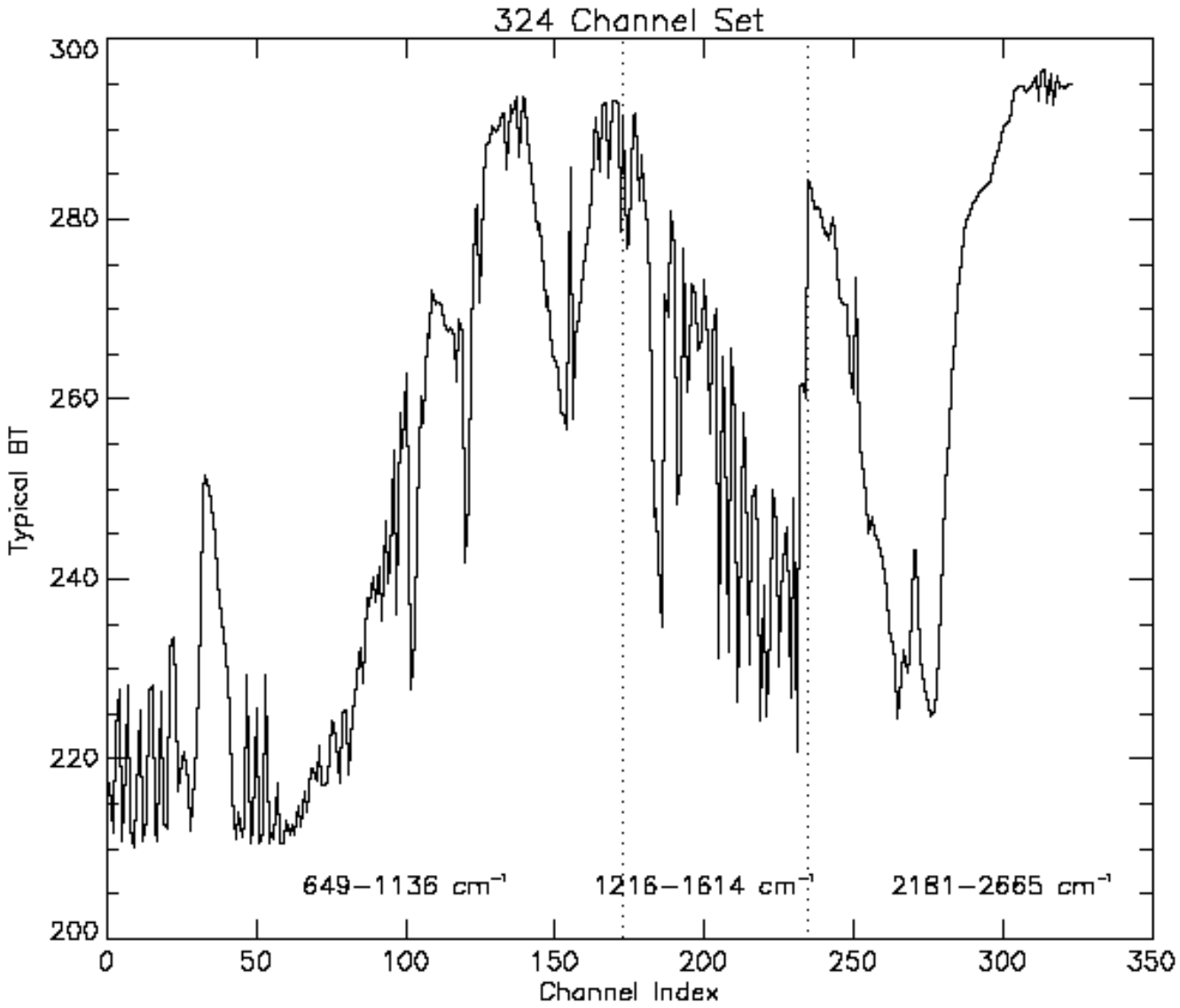
a small background error term.

Connection with Hollingsworth - Lonnberg

Another way to write the same equation:

Left with 2*(noise + humidity perturbations + residual cloud)
For nearby FOV the background error will cancel.

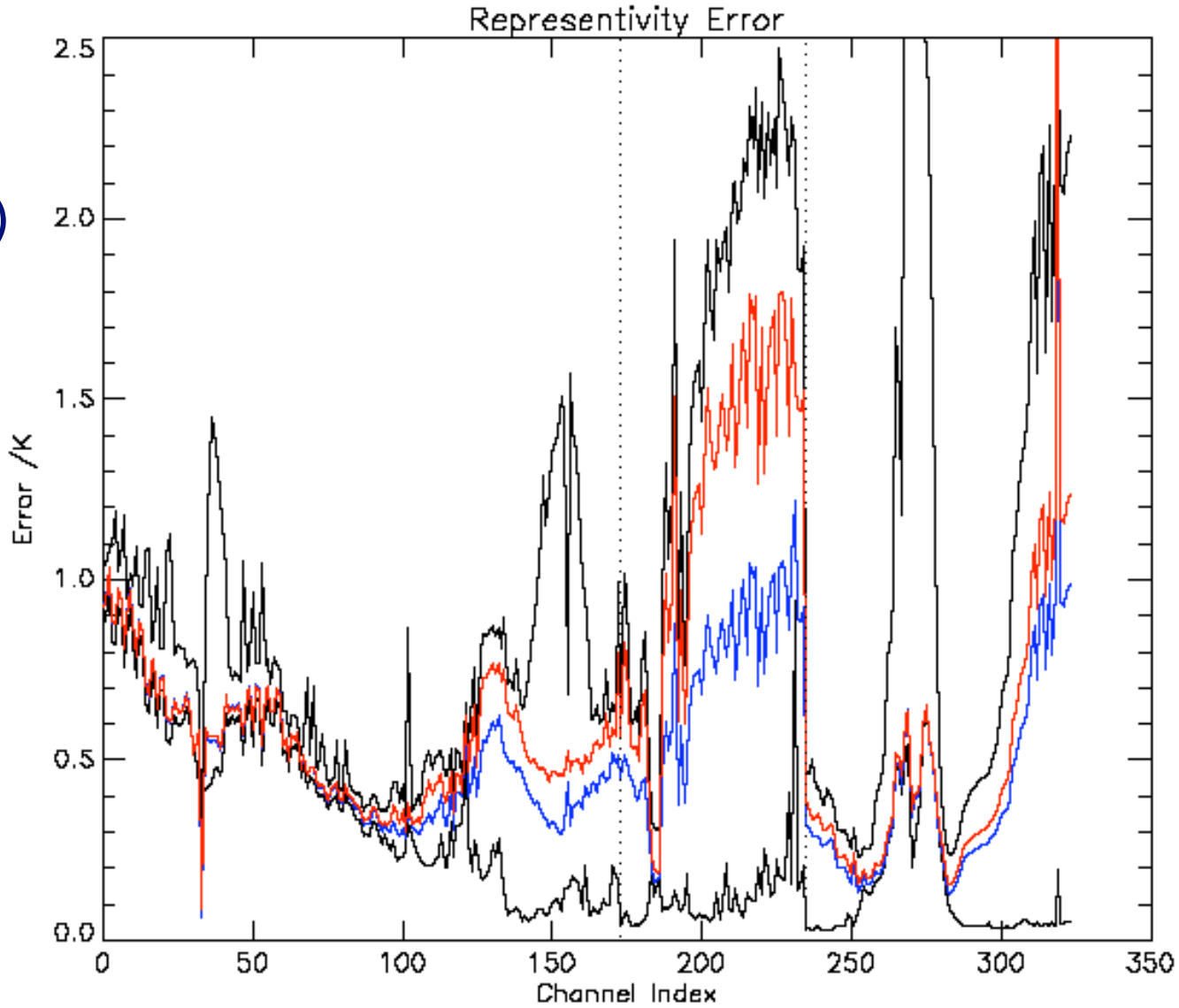
324 Channel Set



Preliminary result for 80km and 200km

Total O-B
and
0.5(cov(O-B,O-B))

- Total (black)
- 200km (red)
- 80km (blue)
- Instrument noise adjusted to typical BT



Future Work

- Day / Night
- Tropics / Extra-tropics
- Full covariance matrix

- Repeat for many more FOV separations
- Collect night-only for short-wave
- Collect statistics in radiance space

Future Developments

Future Developments

Areas we would like to investigate include:

- Trial Reconstructed Radiances.
- Land channel selection.
- Research on channel selection and the background error.
- Cloud cleared data using MODIS (if timely)
- Cloudy radiative transfer.

Questions